NASHUA-MANCHESTER 40818 (CAPITOL CORRIDOR)

APPENDIX E
Air Quality Technical Report

Prepared for:

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Table of Contents

Tables

List of Acronyms and Abbreviations

ADT	average daily traffic
CAA	Clean Air Act
CAFÉ	Corporate Average Fuel Economy
CEQ	Council on Environmental Quality
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
DPM	diesel particulate matter
GHG	greenhouse gasses
GWP	global warming potential
HAPs	hazardous air pollutants
HFCs	hydrofluorocarbons
LOS	level of service
MA	Massachusetts
MassDEP	Massachusetts Department of Environmental Protection
MMT	million metric tons
MSAT	mobile source air toxic
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NH	New Hampshire
NHDES	New Hampshire Department of Environmental Services
NHTSA	National Highway Traffic Safety Administration
N_2O	nitrous oxide
NAAQS	National Ambien Air Quality Standards
NOX	nitrogen oxides
O3	ozone
Pb	lead
PFCs	perfluorocarbons
PM10	particulate matter up to 10 micrometers in diameter
PM2.5	particulate matter up to 2.5 micrometers in diameter
POM	polycyclic organic matter
ppm	parts per million
RAQS	regional air quality strategy
SF_6	sulfur hexafluoride
SIP	state implementation plan
SO_2	sulfur dioxide
TAC	toxic air contaminant
TSP	total suspended particulate
USEPA	United States Environmental Protection Agency
VMT	Vehicle miles traveled
VOC	volatile organic compound

1. Introduction and Regulatory Context

The Nashua-Manchester Regional Commuter Rail Project (the Project) would extend the Massachusetts Bay Transportation Authority (MBTA) commuter rail service approximately 30 miles northward from Lowell, Massachusetts (MA) to Nashua and Manchester, New Hampshire (NH) along the Massachusetts portion of the line owned by MBTA and the New Hampshire portion of the line owned by Pan Am Railways (PAR), acquired in 2022 by CSX Transportation (CSX) (Figure 1). The Project is a collaborative effort led by New Hampshire Department of Transportation (NHDOT) as project proponent in coordination with the MBTA and Massachusetts Department of Transportation (MassDOT). Work within the approximately 9-mile Massachusetts component of the rail corridor would be limited to track and culvert improvements and implementation of a railway signal system within the existing railroad right-of-way. The New Hampshire component extends from the MA/NH state line approximately 21 miles to downtown Manchester, with proposed stations in South Nashua, Crown Street in downtown Nashua, Manchester-Boston Regional Airport in Bedford and a location south of Granite Street in downtown Manchester. A layover facility would also be provided at a location near the planned terminus in the City of Manchester.

This chapter addresses the effects of the proposed Project on future air quality conditions at the regional (mesoscale) and local (microscale) levels. Section 2 discusses the methodology used for the air quality analysis while Sections 3 and 4 described existing air quality conditions and the environmental impact of the Project.

Figure 1: Nashua-Manchester Study Corridor Map

1.1 NAAQS and State Standards

USEPA, in response to the federal Clean Air Act (CAA) of 1970, established National Ambient Air Quality Standards (NAAQS) in Title 40 CFR Part 50. The NAAQS include both primary and secondary standards for six “criteria pollutants.” These criteria pollutants are ozone (O3), CO, NO2, SO2, particulate matter (PM10 and PM2.5), and lead. Primary standards were established to protect human health, and secondary standards were designed to protect property and natural ecosystems from the effects of air pollution.

Ozone. Ozone occurs in two layers of the atmosphere. The layer surrounding the earth’s surface is the troposphere. Here, ground level O3 is an air pollutant that damages human health, vegetation, and many common materials. It is a key ingredient of urban smog. The troposphere extends to a level about 10 miles above the earth’s surface, where it meets the second layer, the stratosphere. In contrast, the beneficial or stratospheric O3 layer extends about 10 to 30 miles from the earth’s surface and protects life on earth from the sun’s harmful ultraviolet rays.

Ground level O3 is what is known as a photochemical pollutant. Significant O3 formation generally requires an adequate amount of precursors in the atmosphere and several hours in a stable atmosphere with strong sunlight for the photochemical reaction to take place.

Ozone is a regional air pollutant. It is generated over a large area and is transported and dispersed based on atmospheric conditions. O3, the primary constituent of smog, is the most complex, difficult to control, and the most pervasive of the criteria pollutants. Unlike other pollutants, O3 is not emitted directly into the air by specific sources. O3 is created by sunlight acting on precursors pollutants, specifically nitrogen oxides (NOX) and volatile organic compounds (VOCs). Sources of precursor gases to the photochemical reaction that form O3 number in the thousands. Common sources include consumer products, gasoline vapors, chemical solvents, and combustion products of various fuels. Originating from gas stations, motor vehicles, large industrial facilities, and small businesses such as bakeries and dry cleaners, the O3 forming chemical reactions often take place in another location, catalyzed by sunlight and heat. High O3 concentrations can form over large regions when emissions from motor vehicles and stationary sources are carried hundreds of miles from their origins.

Particulates. Particulates in the air are caused by a combination of: 1) windblown fugitive dust or road dust; 2) particles emitted directly from combustion sources; and 3) organic, sulfate, ammonium, and nitrate aerosols formed in the air from emitted hydrocarbons, sulfur oxides, ammonia, and nitrogen oxides. Respirable particulate matter is referred to as PM10, which has a diameter of 10 micrometers or less. It can contribute to increased respiratory disease, lung damage, cancer, premature death, as well as reduced visibility and surface soiling. In 1987, the United States Environmental Protection Agency (USEPA) adopted standards for PM10 and phased out the previous standards for total suspended particulate (TSP) that had been in effect.

Fine particulates result from fuel combustion in motor vehicles and industrial sources, residential and agricultural burning, and from atmospheric reactions involving NOX, SOX, and organics. Fine particulates are referred to as PM2.5 and have a diameter equal to or less than 2.5 micrometers. The potential health effects of PM2.5 are considered potentially more serious than those of PM10. In 1997, USEPA established the first annual and 24-hour National Ambient Air Quality Standards (NAAQS) for PM2.5. The standard regulating the 3-year average of the 98th percentile of 24-hour PM2.5 concentrations, or the design value (35µg/m3), became effective on December 17, 2006.

Carbon Monoxide. CO is a product of incomplete combustion of fuels that contain carbon, principally from automobiles and other mobile sources of pollution, but also from stationary combustion sources. In cities, automobile exhaust can cause as much as 95 percent of all CO emissions. These emissions can result in high concentrations of CO, particularly in local areas with heavy traffic congestion. CO emissions from wood-burning stoves and fireplaces can also be important sources of this pollutant. Health effects resulting from exposure to high CO levels can include chest pain in heart patients, headaches, and reduced mental alertness.

Nitrogen Dioxide. Nitrogen oxide emissions are primarily generated from the combustion of fuels in air. Nitrogen oxides include NO and NO2. Because NO reacts to form NO2 in the atmosphere over time and NO2 has been demonstrated to cause the more adverse health effects such as lung irritation and damage, NO2 is the listed criteria pollutant. The control of NO2 is also important because it contributes to the atmospheric formation of ozone, the principal component of smog, and the formation of nitrates which contribute to fine particle formation.

Sulfur Dioxide. SO2 is produced when any sulfur-containing fuel is burned. It is also emitted by chemical plants that treat or refine sulfur or sulfur-containing chemicals. Natural gas contains trace quantities of sulfur, while fuel oils contain much larger amounts. SO2 can increase lung disease and breathing problems for asthmatics. It reacts in the atmosphere to form acid rain, which is destructive to crops and vegetation, as well as to buildings, materials, and works of art. It also contributes to the formation of fine particulate sulfates.

Lead (Pb). Lead exposure can occur through multiple pathways, including inhalation of air and ingestion of lead in food caused by water, soil, or dust contamination. Excessive exposure to lead can trigger seizures, mental disabilities or behavioral disorders, and other central nervous system damage. Lead gasoline additives, nonferrous smelters, and battery manufacturing plants were the most significant contributors to atmospheric lead emissions. Legislation in the early 1970s required gradual reduction of the lead content of gasoline over a period of time, which has dramatically reduced lead emissions from mobile and other combustion sources. These controls have essentially eliminated violations of the lead standard for ambient air in urban areas.

The 1990 CAA Amendments established attainment deadlines for all designated areas that were not in attainment with the NAAQS. In addition to the NAAQS described above, a new federal standard for PM2.5 and a revised O3 standard were promulgated in July 1997. The new federal standards were challenged in a court case during 1998. The court required revisions in both standards before USEPA can enforce them. The U.S. Supreme Court upheld an appeal of the District Court decision in February 2001. These issues were resolved and the 1997 1-hour O3 standard was revoked in 2005, while the revised PM2.5 standard was made effective in 2006. A new 8-hour O3 standard was implemented in 2008. In 2010 new 1-hour SO2 and NO2 standards were implemented and the SO2 24-hour and annual standards were revoked. The 3-hour secondary standard for SO2 remains unchanged. New ozone standards were introduced in 2015. The NAAQS relevant to the Project are summarized in Table 1.

USEPA, Massachusetts Department of Environmental Protection (MassDEP), and New Hampshire Department of Environmental Services (NHDES) determine air quality attainment status by comparing local ambient air quality measurements from the state or local ambient air monitoring stations with the NAAQS. Those areas that meet ambient air quality standards are classified as "attainment" areas; areas that do not meet the standards are classified as "non-attainment" areas. Areas that have insufficient air quality data may be identified as unclassifiable areas. These attainment designations are determined on a pollutant-by-pollutant basis. Non-attainment areas can become reclassified as attainment after ambient measurements show that are in compliance with the NAAQS.

The Project area is classified as attainment with respect to the NAAQS for O3 (2010 standard), NO2, PM10, PM2.5, SO2, and CO and nonattainment area for ozone (1997 standard) and some adjacent areas in New Hampshire are nonattainment area for SO2 (2010 standard). NO2 and SO2 are regulated as PM2.5 precursors, and NO2 and VOCs as O3 precursors. Table 2 presents the nonattainment status for Massachusetts and New Hampshire.

Each of the three project areas were formerly maintenance areas for CO but have each passed the 20-year maintenance period and are now considered fully in attainment.

Table 1. National Ambient Air Quality Standards

Pollutant		Primary/ Secondary	Averaging Time	Level	Form
Carbon Monoxide [76 FR 54294, Aug 31, 2011]		primary	8-hour	9 ppm	Not to be exceeded more than once per year
			1-hour	35 ppm	
Lead [73 FR 66964, Nov 12, 2008]		primary and secondary	Rolling 3-month average	0.15 μg/m3 (1)	Not to be exceeded
Nitrogen Dioxide [75 FR 6474, Feb 9, 2010] [61 FR 52852, Oct 8, 1996]		primary	1-hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		primary and secondary	Annual	53 ppb (2)	Annual Mean
Ozone [73 FR 16436, Mar 27, 2008]		primary and secondary	8-hour	0.07 ppm (3)	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years
Particle Pollution Dec 14, 2012	PM2.5	primary	Annual	12 μg/m3	annual mean, averaged over 3 years
		secondary	Annual	15 μg/m3	annual mean, averaged over 3 years
		primary and secondary	24-hour	35 μg/m3	98th percentile, averaged over 3 years
	PM10	primary and secondary	24-hour	150 μg/m3	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide [75 FR 35520, Jun 22, 2010] [38 FR 25678, Sept 14, 1973]		primary	1-hour	75 ppb (4)	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		secondary	3-hour	0.5 ppm	Not to be exceeded more than once per year

Notes:
(1) Final rule signed October 15, 2008. The 1978 lead standard (1.5 µg/m3 as a quarterly average) remains in effect until one year after an area is designated for the 2008 standard, except that in areas designated nonattainment for the 1978, the 1978 standard remains in effect until implementation plans to attain or maintain the 2008 standard are approved.
(2) The official level of the annual NO2 standard is 0.053 ppm, equal to 53 ppb, which is shown here for the purpose of clearer comparison to the 1-hour standard.
(3) Final rule signed October 1, 2015, and effective December 28, 2015. The previous (2008) O3 standards are not revoked and remain in effect for designated areas. Additionally, some areas may have certain continuing implementation obligations under the prior revoked 1-hour (1979) and 8-hour (1997) O3 standards.
(4) Final rule signed June 2, 2010. The 1971 annual and 24-hour SO2 standards were revoked in that same rulemaking. However, these standards remain in effect until one year after an area is designated for the 2010 standard, except in areas designated nonattainment for the 1971 standards, where the 1971 standards remain in effect until implementation plans to attain or maintain the 2010 standard are approved.
ppm – parts per million (unit of measure for gases only)
ppb – parts per billion (unit of measure for gases only)
µg/m^3 – micrograms per cubic meter (unit of measure for gases and particles, including lead)

Table 2. Nonattainment Status in Massachusetts and New Hampshire

Area	Pollutant	Attainment Status
MA – Boston-Lawrence-Worcester	Ozone (1997 standard)	Nonattainment - Moderate
NH – Central New Hampshire	Sulfur Dioxide (2010 standard)	Nonattainment
NH – Boston-Manchester-Portsmouth	Ozone (1997 standard)	Maintenance

Notes: The NH and MA areas that are not listed here are all in attainment for all pollutants.
NH = New Hampshire
MA = Massachusetts

1.2 Federal Conformity Rules

Pursuant to CAA Section 176(c) requirements, USEPA promulgated Title 40 of the Code of Federal Regulations Part 51 (40 Code of Federal Regulations [CFR] 51) Subpart W and 40 CFR Part 93, Subpart B, —Determining Conformity of General Federal Actions to State or Federal Implementation Plans (see 58 Fed. Reg. 63214 [November 30, 1993], as amended, 75 Fed. Reg. 17253 [April 5, 2010]). These regulations, commonly referred to as the General Conformity Rule, apply to all federal actions including those by Federal Transit Administration (FTA), except for those federal actions which are excluded from review (e.g., stationary source emissions) or related to transportation plans, programs, and projects under Title 23 U.S. Code or the Federal Transit Act, which are subject to Transportation Conformity.

40 CFR Part 51, Subpart W, applies in states where the state has an approved state implementation plan (SIP) revision adopting General Conformity regulations; 40 CFR Part 93, Subpart B, applies in states where the state does not have an approved SIP revision adopting General Conformity regulations.

The General Conformity Rule is used to determine if federal actions meet the requirements of the CAA and the applicable SIP by ensuring that air emissions related to the action do not:

- Cause or contribute to new violations of a NAAQS
- Increase the frequency or severity of any existing violation of a NAAQS
- Delay timely attainment of a NAAQS or interim emission reduction

A conformity determination under the General Conformity Rule is required if the federal agency determines that the action will occur in a nonattainment or maintenance area; one or more specific exemptions do not apply to the action; the action is not included in the federal agency's presumed to conform list; the emissions from the proposed action are not within the approved emissions budget for an applicable facility; and the total direct and indirect emissions of a pollutant (or its precursors), are at or above the *de minimis* levels established in the General Conformity regulations (75 Fed. Reg. 17255). Table 3 presents the applicable *de minimis* emissions levels for this Project.

Table 3. General Conformity de minimis Levels

Pollutant	Federal Attainment Status	Threshold Values (tpy)
Ozone	Nonattainment – Moderate Maintenance	100 for each precursor (NOX and VOC)
SO2	Nonattainment	100

Notes:
typ = ton per year

Conformity regulatory criteria are listed in 40 CFR 93.158. An action will be required to conform to the applicable SIP if, for each pollutant that exceeds the de minimis emissions level in 40 CFR 93.153(b) or otherwise requires a conformity determination due to the total of direct and indirect emissions from the action, the action meets the requirements of 40 CFR 93.158(c).

In addition, federal activities may not cause or contribute to new violations of air quality standards, exacerbate existing violations, or interfere with timely attainment or required interim emissions reductions toward attainment. The proposed Project is subject to review under the USEPA General Conformity Rule.

1.3 Air Toxics Regulations/Standards

USEPA has assessed an expansive list of mobile source air toxics (MSAT) in their latest rule on the Control of Hazardous Air Pollutants (HAPs), also known as air toxics, from Mobile Sources and identified a group of 93 compounds emitted from mobile sources that are listed in their Integrated Risk Information System. The MSAT rules are intended to reduce HAPs emitted by cars and trucks. USEPA identified several compounds with significant contributions from mobile sources that are among the national- and regional-scale cancer risk drivers from the 2005 National Air Toxics Assessment. The most recent Tier 3 EPA rule controlling air pollution from motor vehicles cited the following pollutants of concern which are known or suspected carcinogens or have noncancer effects: acrolein, acetaldehyde, benzene, 1,3-butadiene, formaldehyde, naphthalene, and polycyclic organic matter (POM). Diesel particulate matter (DPM) has also been a concern which has been addressed in previous rulemaking.

1.4 GHG Regulations/Standards

Gases that trap heat in the atmosphere are often called greenhouse gases (GHGs). This layer of gases functions much the same as glass in a greenhouse (i.e., both prevent the escape of heat), which is why this phenomenon is known as the “greenhouse effect.” The greenhouse effect helps to regulate the temperature of the Earth and is essential for life and other natural processes. The greenhouse effect is the result of heat absorption by GHGs and downward re-radiation of some of that heat. The concern is not with the fact that we have a greenhouse effect, but whether human activities are leading to an enhancement of the greenhouse effect by the emission of GHGs through fossil fuel combustion and reduced uptake of GHGs through deforestation. A large body of evidence, accumulated over several decades from hundreds of studies, supports the conclusion that human activity is the primary driver of recent warming (National Climatic Data Center, 2012).

Some GHGs such as carbon dioxide (CO2) occur naturally and are emitted to the atmosphere through natural processes such as volcanoes, forest fires, and biological processes. Other GHGs (e.g., fluorinated gases) are created and emitted solely through human activities. The principal GHGs that enter the atmosphere because of human activities are carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF6). The sources of these emissions associated with human activities are:

- Carbon Dioxide – Carbon dioxide can enter the atmosphere through the burning of fossil fuels, solid waste, trees and wood products, and as a result of other chemical reactions (e.g., manufacture of cement).
- Methane – Methane is emitted during the production and transport of coal, natural gas, and oil. Methane emissions also result from livestock and other agricultural practices and by the decay of organic waste in municipal solid waste landfills.
- Nitrous Oxide – Nitrous oxide is emitted during agricultural and industrial activities, as well as during combustion of fossil fuels and solid waste.

- Synthetic GHGs – Hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride are synthetic, powerful GHGs that are emitted from a variety of industrial processes. For example, sulfur hexafluoride is used in magnesium processing, semiconductor manufacturing, and electrical transmission equipment (circuit breakers), as well as a tracer gas for leak detection. Fluorinated gases are sometimes used as substitutes for ozone-depleting substances (e.g., CFCs, HCFCs, and halons). These gases are typically emitted in smaller quantities, but because they are potent GHGs, they are sometimes referred to as high Global Warming Potential gases.
- The Global Warming Potential (GWP) of each GHG is the ability of that gas to trap heat in the atmosphere relative to CO2. Total GHG emissions are expressed as carbon dioxide equivalent (CO2e) and are the sum of the GWP-weighted emissions of each GHG.
- Climate change refers to any significant change in measures of climate, such as average temperature, precipitation, or wind patterns over a period of time. Climate change may result from natural processes and human activities that change the composition of the atmosphere and alter the surface and features of the land. Significant changes in global climate patterns have recently been associated with global warming, a worldwide average increase in the temperature of the atmosphere near the Earth's surface, attributed to accumulation of GHG emissions in the atmosphere.

Climate change and greenhouse gas (GHG) emission reductions are a concern at the federal level. Laws and regulations, as well as plans and policies, address global climate change issues. This section summarizes key federal regulations relevant to the Project.

In Massachusetts v. U.S. Environmental Protection Agency, et al., 549 U.S. 497 (2007), the United States Supreme Court ruled that GHG does fit within the CAA definition of a pollutant and that USEPA has the authority to regulate GHG.

On September 22, 2009, USEPA published the final rule that requires mandatory reporting of GHG emissions from large sources in the United States. The rule amends CAA Regulations under 40 CFR Parts 86, 87, 89 90 and 94 and provides a new section, Part 98. USEPA uses the reports to collect accurate and comprehensive emissions data that can inform future policy decisions. Facilities that emit 25,000 metric tons or more per year of GHG emissions must submit annual reports to USEPA under Subpart C of the final rule. GHGs covered by the final rule are carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF6), and other fluorinated gases including nitrogen trifluoride (NF3) and hydrofluorinated ethers (HFEs). This is not a transportation-related regulation. However, the methodology developed as part of this regulation is helpful in identifying potential GHG emissions.

On October 5, 2009, President Obama signed Executive Order (E.O.) 13514; Federal Leadership in Environmental, Energy, and Economic Performance. E.O. 13514 requires Federal agencies to set a 2020 GHG emission-reduction target within 90 days, increase energy efficiency, reduce fleet petroleum consumption, conserve water, reduce waste, support sustainable communities, and leverage federal purchasing power to promote environmentally responsible products and technologies.

On December 7, 2009, the Final Endangerment and Cause or Contribute Findings for Greenhouse Gases (endangerment finding), under Section 202(a) of the CAA, went into effect. The endangerment finding states that current and projected concentrations of the six key well-mixed GHGs in the atmosphere (CO2, CH4, N2O, HFCs, PFCs, and SF6) threaten the public health and welfare of current and future generations. Furthermore, it states that the combined emissions of these well-mixed GHGs from new motor vehicles and new motor vehicle engines contribute to the GHG pollution, which threatens public health and welfare (USEPA 2010a).

Based on the endangerment finding, USEPA is revising vehicle emission standards under the CAA. USEPA and National Highway Traffic Safety Administration (NHTSA) updated the Corporate Average Fuel Economy (CAFE) fuel standards on May 7, 2010 (75 Fed. Reg. 25324), requiring substantial improvements in fuel economy for all vehicles sold in the Unites States. The new standards apply to new passenger cars, light-duty trucks, and medium-duty passenger vehicles, covering model years 2012 through 2016. The USEPA GHG standards require these vehicles to meet an estimated combined average emissions level of 250 grams of CO2 per mile in the model year 2016, which would be the equivalent to 35.5 miles per gallon if the automotive industry were to meet this CO2 level solely through fuel economy improvements.

On September 15, 2011, USEPA and NHTSA issued a Final Rule of Greenhouse Gas Emissions Standards and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles (76 Fed. Reg. 57107). This final rule is tailored to each of the three regulatory categories of heavy-duty vehicles: combination tractors, heavy-duty pickup trucks and cars, and vocational vehicles. USEPA and NHTSA estimated that the new standards in this rule will reduce CO2 emissions by approximately 270 million metric tons (MMT) and save 530 million barrels of oil over the life of vehicles sold during the 2014 through 2018 model years. Newer efficiency standards have been issued by NTHSA on May 2, 2022 (87 FR 25710) for passenger cars and light trucks which come into effect for 2024 through 2026 model years to provide a fleet-wide average fuel economy of 49 mpg on model year 2026. A second phase of standards for medium duty and heavy-duty trucks has been stayed by court order.

On February 18, 2010, the White House Council on Environmental Quality (CEQ) released draft guidance regarding the consideration of GHG in National Environmental Policy Act (NEPA) documents for federal actions. The draft guidelines included a presumptive threshold of 25,000 metric tons of carbon dioxide equivalent (CO2e) emissions from a proposed action to trigger a quantitative analysis. CEQ has not established when GHG emissions are —significant for NEPA purposes; rather, it poses the question to the public (CEQ 2010). The guidance was finalized on August 1, 2016 without enumerating a threshold amount, but does recommend that both direct and indirect GHG emissions which are reasonably foreseeable be included in the analysis along with alternatives and mitigation strategies. The 2016 guidance document was withdrawn on April 5, 2017 and draft replacement guidance document was issued June 26, 2019. The 2019 draft guidance was subsequently rescinded February 19, 2019 and the 2016 final guidance was reinstated and is currently under review for revision and update. FTA has published guidance and a spreadsheet tool for transit projects which are based on the 2016 CEQ guidance document which are used to estimate the direct (downstream) and indirect (upstream) GHG emissions from the proposed Project.

2. Methodology

2.1 Local Impact (micro-scale Analysis)

On a local scale, the potential effect of the Project on air quality is limited to increases in locomotive emissions, and the corresponding change in on-road emissions. Decreases in on-road emissions could have a beneficial impact on local air quality if large numbers of vehicle trips are shifted to rail, occurring along roadways where those trips would otherwise occur. Since the details of that shift are not clearly known at this time, this potential benefit has not been analyzed; however, a more meaningful analysis of the region-wide benefits of this mode shift is included in the regional analysis.

Mobile source dispersion models are the basic analytical tools used to estimate hotspot concentrations expected under given traffic, roadway geometry, and meteorological conditions. However, quantitative CO hotspot and PM hotspot analyses for this Project are not required in this impact analysis report because the Project is located in federal attainment areas for those pollutants. Therefore, dispersion modeling was not used for the Project. The Project is subject to the general conformity guidelines but not the transportation conformity guidelines. Therefore, the micro-scale analysis focuses on the potential local effect associated with increases in locomotive emissions.

Locomotive emissions factors for NOX, CO, PM, and total hydrocarbons (HC) are based on an engine certified to USEPA Tier 4 emission standards which is likely to be in use during the Project timeframe. For criteria pollutants which do not have specific EPA standards, EPA guidance documents for nonroad engines were used. PM10 is assumed to be the same as PM, PM2.5 is assumed to be 97% of PM, VOC is derived from HC after subtracting methane. SO2 emissions are based on use of ultra-low sulfur diesel fuel (15 ppmw). The total emissions were distributed to each State based on a ridership analysis study.

2.2 Regional Impact (meso-scale Analysis)

2.2.1 Criteria Pollutants

The regional impact (meso-scale emissions analysis) estimates the net change in emissions associated with the entire Project, including the change in both on-road and locomotive emissions for the Manchester Regional Commuter Rail. The locomotive emission factors used are described in the local impact (micro-scale analysis) section above. An on-road vehicle emission analysis was also conducted using average daily vehicle miles traveled (VMT) estimates and associated average daily speed estimates for each affected area. The criteria pollutant emission factors for on-road vehicles were obtained using the USEPA MOVES3 emissions model. For this analysis, the MOVES3 model was ran at the national scale with national input data allocated to Hillsborough and Merrimack Counties in New Hampshire. Total vehicle miles-traveled (VMT) were obtained from the Project traffic study. The analysis was conducted for the unconstrained modeling year 2040. The analysis was based on the weekday service and the VMT reduction would be greater when weekend service is considered.

To determine overall pollutant burdens generated by on-road vehicles, estimated VMT increases or decreases were multiplied by applicable pollutant’s emission factors, which are based on national default speeds and vehicle speciation data, and using a 2040 analysis year.

2.2.2 Hazardous Air Pollutants, Greenhouse Gases, and Other Pollutants

The federal Clean Air Act (CAA) Amendments of 1990 listed 188 Hazardous Air Pollutants (HAPs) and addressed the need to control toxic emissions from transportation. USEPA's 2007 Mobile Source Air Toxics (MSAT) rule identified a subset of seven HAPs as having significant contributions from mobile sources: benzene, 1,3-butadiene, formaldehyde, acrolein, naphthalene, polycyclic organic matter (POM), and diesel particulate matter (DPM).

Gaseous HAP emissions (1,3-butadiene, acrolein, formaldehyde, and benzene) for on-road vehicles are based on MOVES3 modeling. Gaseous HAP emissions for locomotive engines are based on EPA guidance document factors for nonroad engines where 1,3-butadiene, acrolein, formaldehyde, and benzene are fractions of VOC emissions. Naphthalene and total PAH for both on-road and offroad engines are calculated using factors which are fractions of VOC and PM2.5 since these compounds exist in gaseous and particulate phases.

GHG emissions from vehicles and locomotives are based on the FTA Transit Greenhous Gas Emissions Estimator v3.0. This spreadsheet tool provides upstream and downstream CO2e emissions from project related construction activities, maintenance, facility and vehicle operations, and displaced emissions as a result of a transit project.

3. Existing Conditions

Ambient air quality standards have been set by both the federal government, MassDEP, and NHDES to protect public health and welfare with an adequate margin of safety. However, according to the MassDEP, the state does not designate areas as attainment or nonattainment with these standards. Pollutants for which NAAQS have been established are often referred to as “criteria” air pollutants. This term is derived from the comprehensive health and damage effects review that culminates in pollutant-specific air quality criteria documents, which precede the establishment of NAAQS. These standards are reviewed on a legally prescribed frequency and revised as warranted by new health and welfare effects data. Each NAAQS is based on a specific averaging time over which the concentration is measured. Different averaging times are based upon protection against short-term, high-dosage effects or longer-term, low-dosage effects. Most NAAQS may be exceeded no more than once per year. A listing of the current NAAQS is provided in Section 1.2, NAAQS and State Standards.

The ambient air quality in the project area is monitored at a number of permanent air quality monitoring stations operated by USEPA, MassDEP, and NHDES. The monitoring stations within Massachusetts that are closest to the Project area are in Chelmsford (Manning Road and Technology Drive), Haverhill, and Boston (Kenmore Square and Roxbury). In New Hampshire the monitoring stations nearest to the Project area are in Nashua (Gilson Road), Concord (Pleasant Street), Peterborough (Miller State Park), and Londonderry (Moosehill School). For each pollutant, the maximum concentration from these stations was selected as a conservative background concentration level. Background concentration data is presented in Tables 4 to Table 9.

These tables show that within the 3-year monitoring periods air quality concentrations have remained relatively steady. Given the conservative nature of these monitored concentrations and the fact they are no NAAQS exceedances, it can be concluded that air quality data within the project area shows compliance with the NAAQS as well. The change in emissions associated with the project (as shown in Section 4) will not impact the regions attainment status.

Table 4. Concentration Data Summary for Ozone (NAAQS = 0.07 ppm [8hr])

State	Year	Highest 4th Highest Concentration for O_3 (ppm) 8-hr	Number of Days Exceeding Standards 8-hr
Massachusetts	2019	0.061	0
	2020	0.057	0
	2021	0.060	0
New Hampshire	2019	0.057	1*
	2020	0.056	0
	2021	0.057	0

Notes: ppm = parts per millions
** exceedance is noted at the highest monitored concentration, not the highest 4th high consistent with the NAAQS.*
MA data from the Boston (Roxbury/Harrison Avenue) monitor
NH data from the Londonderry (Moosehill School) monitor

Table 5. Concentration Data Summary for Nitrogen Dioxide (NAAQS = 100 ppb [1hr], 53 ppb [annual])

State	Year	98th Percentile Concentration NO2 (ppb) 1-hr	Annual Mean (ppb)	Number of Days Exceeding Standards (days) 1-hr
Massachusetts	2019	44	12.42	0
	2020	42	10.32	0
	2021	43	10.12	0
New Hampshire	2019	21	3.0	0
	2020	20	2.0	0
	2021	27	3.1	0

Notes: ppb = parts per billions
MA data from the Boston (Kenmore) monitor
NH data from the Londonderry (Moosehill School) monitor
(illustrative value only for 2021 as insufficient data recorded from monitor)

Table 6. Concentration Data Summary for Sulfur Dioxide (NAAQS = 75 ppb [1hr], 0.5 ppm [3hr])

		99th Percentile Concentration for SO_2 (ppb)	Highest 2nd Highest Concentration for SO_2 (ppb)	Number of Days Exceeding Standards	
		1-hr	3-hr	1-hr	3-hr
Massachusetts	2019	1.7	1.6	0	0
	2020	2.0	1.7	0	0
	2021	2.1	1.5	0	0
New Hampshire	2019	18.7	19.9	0	0
	2020	23.5	19.4	0	0
	2021	57.3	53.9	0	0

Notes: ppb = parts per billions
MA data from the Boston (Roxbury/Harrison Avenue) monitor
NH data from Concord (Pembroke Hwy/Pleasant Street) monitor

Table 7. Concentration Data Summary for Carbon Monoxide(NAAQS = 35 ppm [1hr], 9 ppm [8hr])

		Highest 2nd Highest Concentration for CO (ppm)		Number of Days Exceeding Standards	
State	**Year**	**1-hr**	**8-hr**	**1-hr**	**8-hr**
Massachusetts	2019	1.6	1.0	0	0
	2020	1.6	1.1	0	0
	2021	1.5	1.9	0	0
New Hampshire	2019	0.5	0.4	0	0
	2020	0.6	0.6	0	0
	2021	0.6	0.6	0	0

Notes: ppm = parts per millions
MA data from the Boston (Roxbury/Harrison Ave) monitor
NH data from the Londonderry (Moosehill School) monitor

Table 8. Concentration Data Summary for PM2.5 (NAAQS = 35 μg/m^3 [24hr], 12 μg/m^3 [annual])

State	Year	98th Percentile Concentration for PM2.5 (μg/m^3) 24-hr	Annual Arithmetic Mean for PM2.5 (μg/m^3)	Number of Days Exceeding Standard (days) 24-hr
Massachusetts	2019	17.0	8.08	0
	2020	14.3	5.75	0
	2021	14.3	5.27	0
New Hampshire	2019	11.7	4.7	0
	2020	12.8	5.9	0
	2021	16.1	3.5	0

Notes: ppm = parts per millions
MA data from the Boston (Roxbury/Harrison Avenue) monitor
NH data from the Londonderry (Moosehill School) monitor

Table 9. Concentration Data Summary for PM10 (NAAQS = 150 µg/m^3 [24hr])

State	Year	Highest 2nd Highest Concentration for PM10 (µg/m^3) 24-hr	Number of Days Exceeding Standards (days) 24-hr
Massachusetts	2019	27	0
	2020	25	0
	2021	30	0
New Hampshire	2019	34	0
	2020	24	0
	2021	50	0

Notes: ppm = parts per millions
MA data from the Boston (Roxbury/Harrison Ave) monitor
NH data from the Londonderry (Moosehill School) monitor for 2020, 2021 and from Portsmouth (Peirce Island) for 2019

4. Environmental Consequences

4.1 Local Analysis Results

The results of the micro-scale analysis are presented in Table 10. The results represent the Project emissions increases as a result of the additional locomotive emissions along the track and at stations for the Manchester Regional Commuter Rail. These emission increases do NOT account for any future line electrification and therefore are likely conservative estimates. In addition, all locomotive emissions are based on a similar engine from EPA's "Annual Certification Data for Vehicles, Engines, and Equipment"[1], which meet or are more stringent than EPA's Tier 4 standards. The specific model is based on a Locomotive MP54AC with Cummins QK60 twin engine as referenced in the 2020 MBTA rail vision analysis report[2].

Table 10. Local Air Quality Impacts from Locomotives

Annual Emissions (tons/year)	CO	NOX	PM10	PM2.5	SO2	VOC
MA Total	0.46	3.67	0.05	0.04	0.02	0.12
NH Total	1.62	12.94	0.16	0.16	0.07	0.44
Idling emissions	0.04	4.87	0.00	0.00	0.00	0.01
Total Emissions	**2.11**	**21.48**	**0.21**	**0.20**	**0.09**	**0.58**
Applicable General Conformity Emission *de minimus* level (to each nonattainment or maintenance area)	**NA**	**100**	**NA**	**NA**	**100**	**100**
Exceed *de minimus* level?	**NA**	**No**	**NA**	**NA**	**No**	**No**

Notes:
NA = Not applicable
NAA = Nonattainment area
NH = New Hampshire
MA = Massachusetts

Since mobile source dispersion modeling and hotspot analyses are not required for this analysis, the results of the micro-scale emissions presented in Table 10 show that project emissions are below the federal general conformity de minimis levels for all applicable criteria pollutants in each nonattainment or maintenance area in New Hampshire and Massachusetts. Therefore, the local air quality impact will not be significant due to Project operations.

4.2 Regional Analysis Results

4.2.1 Criteria Pollutant Results

The total net change in criteria pollutant emissions in the Project's affected region from the Manchester Regional Commuter Rail Alternative are presented in Table 11. Table 11 shows the net change in emissions associated with the Project that accounts for the emission increases from locomotive emissions and emission decreases associated with reduction in on on-road emissions associated with traffic reductions. There will be very little change in emissions for all criteria pollutants except for NOX with all

[1] https://www.epa.gov/system/files/documents/2023-01/locomotive-2007-present.xlsx
[2] https://cdn.mbta.com/sites/default/files/2021-07/2020-02-rail-vision-appendix-f.pdf

net emissions changes below the federal general conformity de minimis levels. Therefore, the project is presumed to conform to the applicable SIPs and would not require a full conformity analysis and conformity determination.

Table 11. Regional Air Quality Impact – Criteria

Emissions Increase (tons/year)	CO	NOX	PM10	PM2.5	SO2	VOC
Personal Vehicles – MA	-15.55	-0.38	-0.15	-0.03	-0.02	-1.29
Personal Vehicles – NH	-8.58	-0.21	-0.07	-0.02	-0.01	-0.70
Personal Vehicles – Total	**-24.13**	**-0.58**	**-0.22**	**-0.05**	**-0.03**	**-1.99**
Boston Express Buses – MA	-1.45	-0.50	-0.01	-0.00	-0.00	-0.04
Boston Express Buses – NH	-0.73	-0.21	-0.00	-0.00	-0.00	-0.02
Boston Express Buses – Total	**-2.18**	**-0.72**	**-0.02**	**-0.00**	**-0.00**	**-0.06**
Locomotive – MA	0.66	5.28	0.07	0.06	0.03	0.18
Locomotive – NH	1.46	16.26	0.15	0.14	0.07	0.40
Locomotive – Total	**2.12**	**21.54**	**0.21**	**0.21**	**0.09**	**0.58**
Net Emissions Change – MA	-16.34	4.40	-0.09	0.03	-0.01	-1.15
Net Emissions Change – NH	-7.85	15.84	0.07	0.12	0.05	-0.31
Net Emissions Change – Total	**-24.19**	**20.24**	**-0.02**	**0.15**	**0.06**	**-1.46**
Applicable General Conformity Emission *de minimus* level (to each nonattainment or maintenance area)	**NA**	**100**	**NA**	**NA**	**100**	**100**
Exceed *de minimus* level?	NA	No	NA	NA	No	No

Notes: NA = Not applicable

4.2.2 Hazardous Pollutant Emissions Results

The total net change in HAPs emissions in the project's affected region from the Manchester Regional Commuter Rail are presented in Table 12. Lead emissions were not included because lead is not an available pollutant in MOVES3 and is not listed in the MOVES3 guidance documents for on-road or nonroad engines. DPM emissions are conservatively assumed to be the same as the PM2.5 emissions in Table 11.

USEPA regulations for on-road vehicle engines and fuels will cause overall MSAT emissions to decline significantly over the next several decades in three ways: (1) by lowering the benzene content in gasoline; (2) by reducing exhaust emissions from passenger vehicles operated at cold temperatures; and (3) by reducing emissions that evaporate from, and permeate through, portable fuel containers. Federal regulations are also severely reducing the diesel emissions from both on-road and non-road vehicles, and diesel PM is therefore also expected to diminish over time. In general, the impacts are expected to be much lower than those presented in Table 11.

Table 12. Regional Air Quality Impact – Hazardous Air Pollutants

Net Emissions (tons/year)	1,3 Butadiene	Acrolein	Formaldehyde	Benzene	Naphthalene	Polycyclic organic matter	DPM
Net Emissions Increases	(0.006)	0.01	0.09	0.14	(0.001)	(0.001)	0.15

Notes: NA = Not applicable

4.2.3 Greenhouse Gas Results

The estimated annual operational emissions of GHGs associated with the Manchester Regional Commuter Rail are presented in Table 13, which shows an annual net increase in GHG emissions associated with the Project compared to the future No-Build.

As previously stated, FTA has developed a spreadsheet tool to estimate emissions from transit projects. The Transit Greenhous Gas Emissions Estimator v3.0 was released in April 2022. This tool estimates upstream and downstream GHG emissions from project construction and operations. Upstream emissions are those associated with the extraction, transport, and production of the materials used in construction and vehicle fuel. Downstream emissions are those associated with tailpipe emissions from construction equipment and transit vehicles. Operations include maintenance and use of vehicles. The tool provides GHG emissions as metric tons of carbon dioxide equivalent (MT CO2e), which accounts for all individual species of the relevant GHG combined into a single number. Inputs to the tool include miles of track, number of stations, parking spots, number of trees removed, size of building constructed, and miles based on mode of transportation both for the project and displaced. Displaced miles are when automobile and bus users switch to using the new rail service, thereby reducing auto and bus vehicle miles. Some limitations of the FTA tool are the lack of specific station types to commuter rail and restricting commuter rail to only new track construction rather than converted/upgraded track. This leads to a very conservative (high) estimate of construction GHG. The user's guide to the FTA tool comments that the only factors available are based on heavy rail stations with no data specific to commuter rail and does not provide a specific choice of full station versus platform. Tables 13 presents a high-level summary of the results of the tool and Table 14 presents the results of the tool for each state.

Table 13. Greenhouse Gases Upstream and Downstream

Net Emissions	Upstream	Downstream	Total
Construction (MT CO2e/Project)	**514,734**	**16,193**	**530,927**
Transit Maintenance (MT CO2e/yr)	0	133	133
Facility Operation (MT CO2e/yr)	0	10	10
Vehicle Operations (MT CO2e/yr)	0	6,982	6,982
Vehicle Maintenance (MT CO2e/yr)	0	243	243
Displaced Emissions (MT CO2e/yr)	-1,277	-5,454	-6,731
Annual Net Emissions Change – Non-Construction Total (MT CO2e/yr)	**-1,277**	**1,914**	**636**

Table 14. Upstream and Downstream GHG by State

Net Emissions	MA Upstream	MA Downstream	NH Upstream	NH Downstream
Construction (MT CO2e/Project)	**7,648**	**4,370**	**507,086**	**11,823**
Transit Maintenance (MT CO2e/yr)	0	42	0	91
Facility Operation (MT CO2e/yr)	0	0	0	10
Vehicle Operations (MT CO2e/yr)	0	2,215	0	4,767
Vehicle Maintenance (MT CO2e/yr)	0	77	0	166
Displaced Emissions (MT CO2e/yr)	-829	-3,539	-449	-1,915
Annual Net Emissions Change – Non-Construction Total (MT CO2e/yr)	**-829**	**-1,204**	**-449**	**3,118**

The results shown in Tables 13 and 14 assume only a small reduction in the number of express buses in the corridor under the Build compared to the No-Build. The spreadsheet tool was also used to test a scenario where the number of express buses in the Build alternative would be reduced by half of what they are in the No-Build, which is still a conservative assumption relative to levels of express bus service in peer corridors with commuter rail service, such as Worcester-Boston and Providence-Boston. Tables 15 and 16 present the greenhouse gas results under this scenario.

Table 15. Greenhouse Gases Upstream and Downstream

Net Emissions	Upstream	Downstream	Total
Construction (MT CO2e/Project)	**514,734**	**16,193**	**530,927**
Transit Maintenance (MT CO2e/yr)	0	133	133
Facility Operation (MT CO2e/yr)	0	10	10
Vehicle Operations (MT CO2e/yr)	0	6,982	6,982
Vehicle Maintenance (MT CO2e/yr)	0	243	243
Displaced Emissions (MT CO2e/yr)	-1,524	-6,646	-8,170
Annual Net Emissions Change – Non-Construction Total (MT CO2e/yr)	**-1,524**	**721**	**-803**

Table 16. Upstream and Downstream GHG by State

Net Emissions	MA Upstream	MA Downstream	NH Upstream	NH Downstream
Construction (MT CO2e/Project)	**7,648**	**4,370**	**507,086**	**11,823**
Transit Maintenance (MT CO2e/yr)	0	42	0	91
Facility Operation (MT CO2e/yr)	0	0	0	10
Vehicle Operations (MT CO2e/yr)	0	2,215	0	4,767
Vehicle Maintenance (MT CO2e/yr)	0	77	0	166
Displaced Emissions (MT CO2e/yr)	-996	-4,347	-528	-2,299
Annual Net Emissions Change – Non-Construction Total (MT CO2e/yr)	**-996**	**-2,012**	**-528**	**2,734**

5. Potential Mitigation Strategies

Since global climate change is caused cumulatively by world-wide activity, the impact of a specific program on climate change cannot be determined. Therefore, the approach applied here for evaluating the potential impact of the program is to identify the program's potential GHG emissions, and to evaluate whether it incorporates cost-effective energy efficiency and renewable energy measures into its design, construction, and operation to the maximum extent practicable, consistent with social, economic and other essential considerations. By doing so, the program would demonstrate consistency with state and local policies.

Since this is a project-level impact analysis, the details of design, construction, and operation are not yet fully available. Therefore, this section identifies potential measures for inclusion, which would reduce the program's energy and GHG footprint if implemented. These measures will be further investigated, and if found to be practicable, incorporated in the program's design and operation.

Operational

Change the Fuel to Biodiesel Fuel—Options to use biodiesel for the locomotives will be investigated, including blends of B20 and B100 (20 percent biodiesel with 80 percent standard diesel, or pure biodiesel). Also, the project proposes a new layover in Manchester at which the locomotives will plug in to power to enable them to shut down overnight vastly reducing emissions from idling. B20 can be used with current technology while B100 may require some adjustments or new engines. The use of B20 would reduce GHG emissions by 10 percent, and B100 would reduce GHG emissions by 70 percent.

Electrification—The benefits of shifting rail operations along the entire line to electricity have not been quantified at this time. Benefits would increase over the years as the New Hampshire grid shifts to increasingly higher fractions of renewable power sources (the New Hampshire grid currently includes relatively large fractions of nuclear and hydro power, which result in very little GHG emissions). The layover station will allow the trains to plug into the grid for operating HVAC operations and shut down the engines overnight.

Sustainable Station Design and Construction—Although station energy use was not included in this analysis, new stations would be designed in accordance with the new requirements from the State.

Construction

Use of Local, Renewable, Recycled Materials—The majority of construction emissions are estimated to come from the extraction, production, transport, and disposal of construction materials. Although precise details are not known at this time, the reduction in these emissions can be substantial if local, renewable, and recycled materials are used. The largest contributors are cement and steel. If emissions associated with material can be cut in half (existing strategies demonstrate that this is possible), the emissions payback period could be reduced by nearly 40 percent.

Biodiesel for Construction Engines—Biodiesel blends would be used in construction engines to the extent practicable.

Replanting Trees—Trees that need to be removed for construction would be replaced with a larger number of trees, replacing the trees in kind or greater.

6. References

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